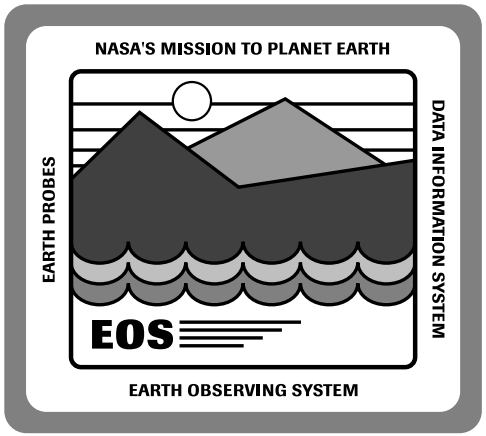
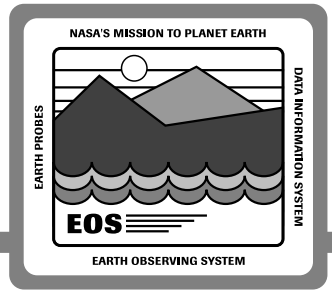


Cost/Performance

Joe Guzek

13 - 14 December 1993

Cost/Performance Roadmap



SRR Issue Description

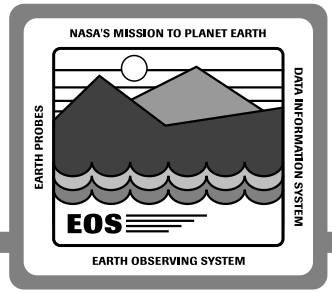
Cost/Performance Analysis Approach

Baseline Cost Allocation (Preface to Tradeoffs)

Cost Tradeoff Analysis

- **Operations Staffing Options**
- **Evaluation of increased processing/storage requirements of "tall-pole" products**
- **Processing vs Storage**

Cost/Performance Issues Heard at SRR



SRR presented cost drivers with no relative cost sensitivity information

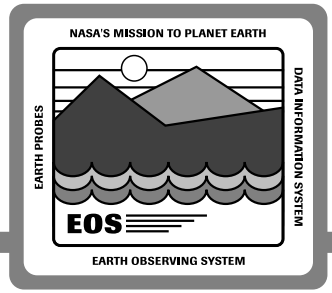
Cost models too conservative about the likely advances in computing technology

Costs seem too sensitive to floating-point operations required for product production

Cost constraints are more likely in populations of users and the rates that they may be served

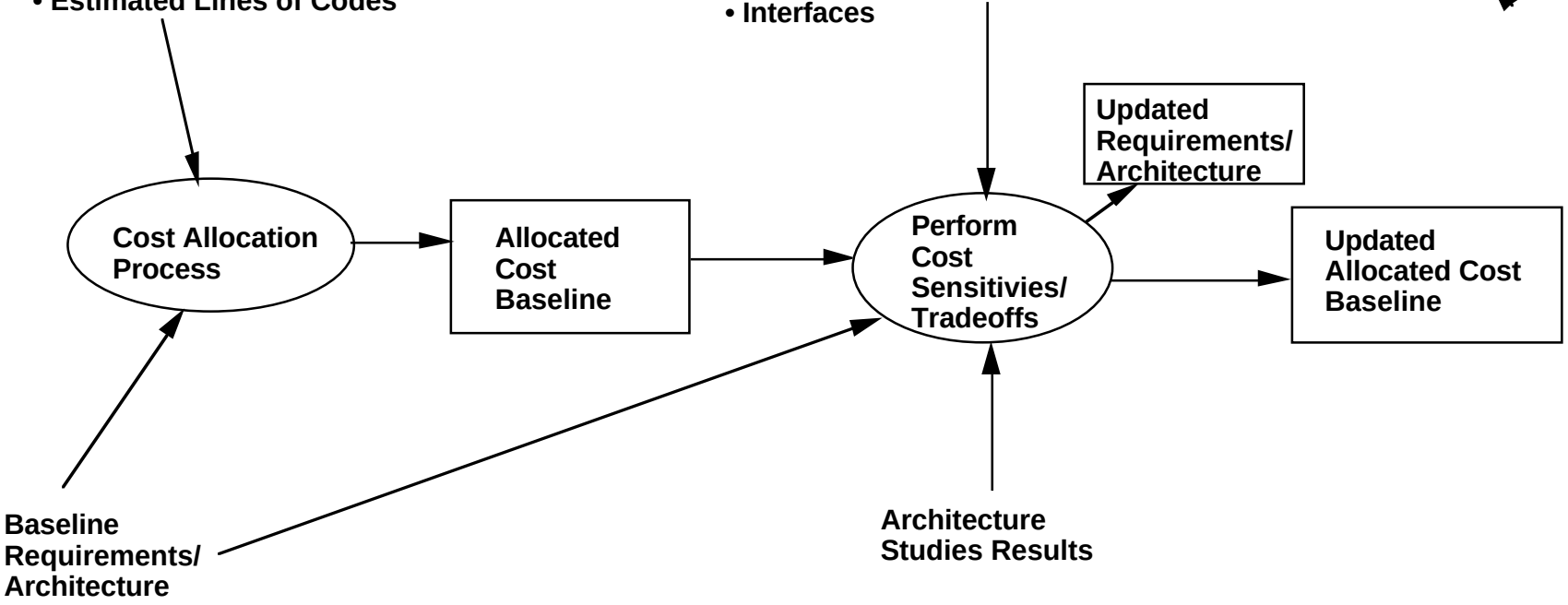
Need to know relative cost of various functions to make priority tradeoffs

Cost/Performance Analysis

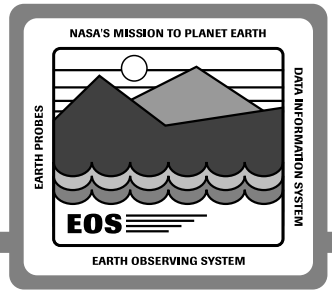


Cost Parameters (Drivers)
- Processing Requirements
- Storage Requirements
- Data Distribution Requirements
- User System Access Patterns
- Site Operational Support
- Complexity of Instrument Operations
- External Interfaces
- Estimated Lines of Codes

Refined Cost Drivers
- Refined Requirements from User/Data Model
- Updated Product List (Processing/Storage Requirements)
- Tradeoff Requirements based on Science Priorities
- Service Definitions
- Infrastructure Definition
- Interfaces



Cost/Performance Roadmap



SRR Issue Description

Cost/Performance Analysis Approach

→ **Baseline Cost Allocation (Preface to Tradeoffs)**

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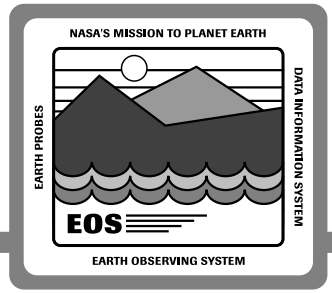
Cost Allocation



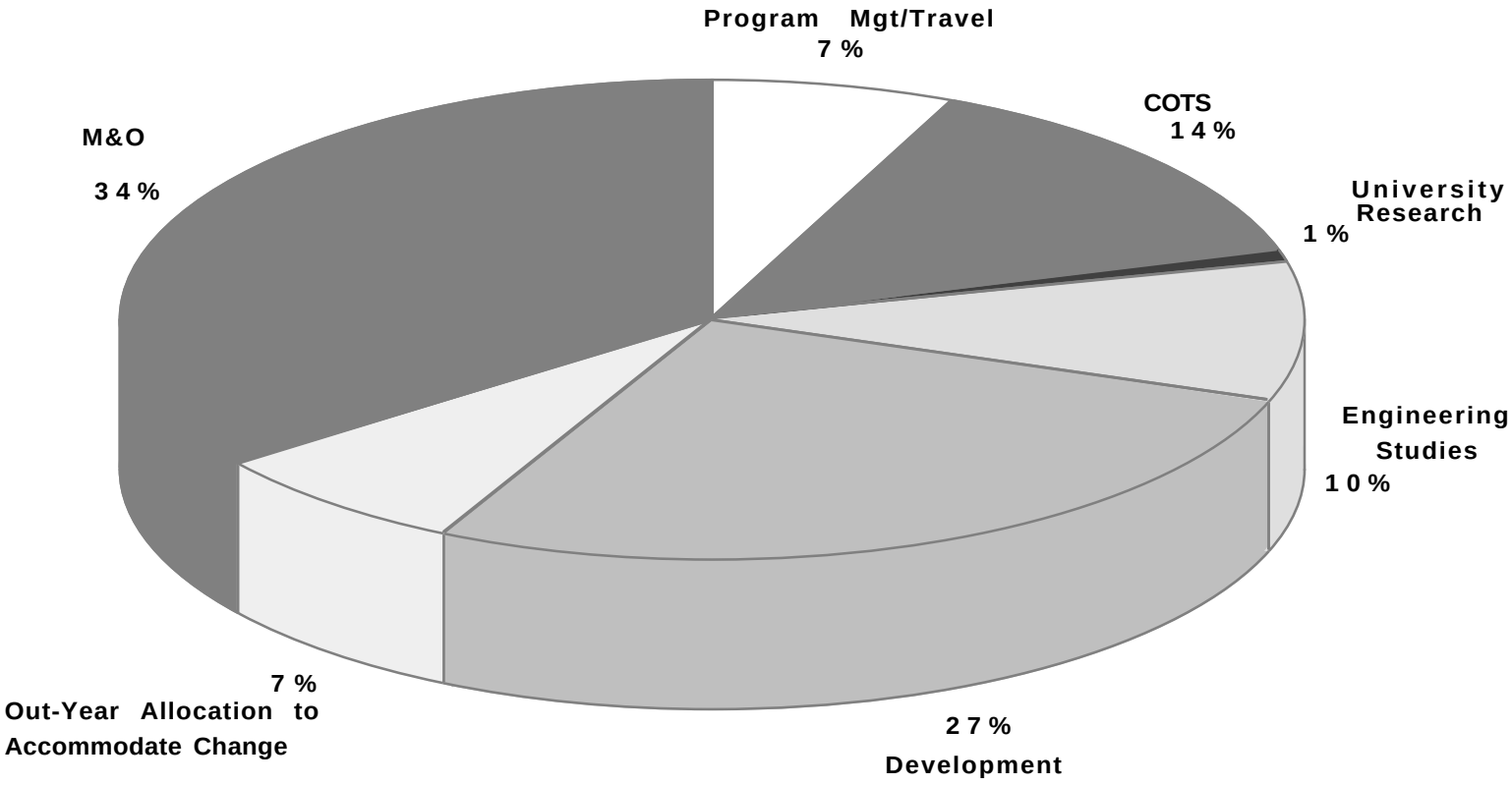
Cost allocations based upon historical models, modified for evolutionary development, and intensive negotiations

- **Evolutionary development**
  - **Prototyping effort**
  - **Out-year allocation to accommodate change**

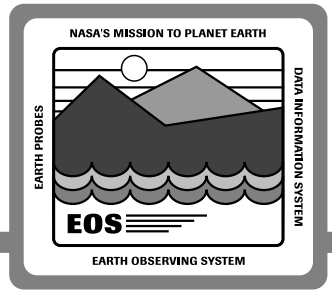
Presented as aid in doing cost sensitivity analysis

Cost Allocation of Negotiated Baseline (Total Program)

Total Program = $766M



Cost Allocation Backup Information
(Total Program)



Out-Year Allocation to accommodate change

- **Effort allocated post 98**
- **Includes Science Office, engineering, development effort to evolve system based on user feedback, technology enhancements**
- **Includes amount for COTS evolution**

Engineering Studies

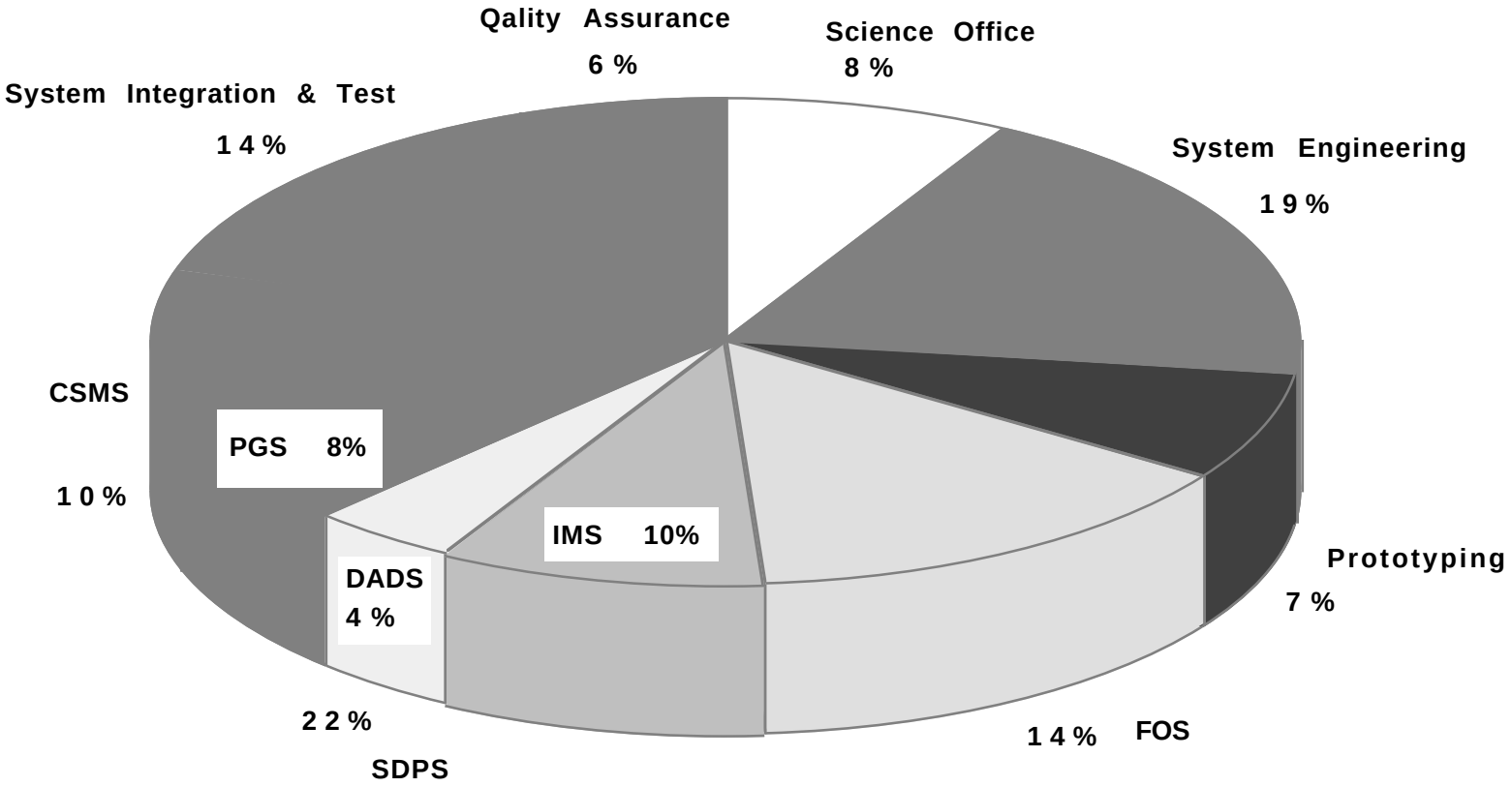
- **Effort used to support special studies, analysis and development**
- **Data migration support**
- **Allocation on task direction from ESDIS**

University Research

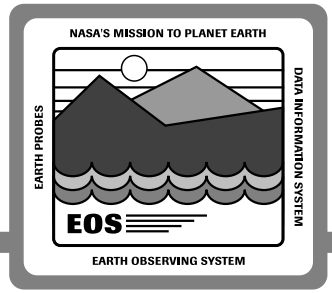
- **Educational research for prototyping in areas of user interfaces, data access and management and other key technologies**
- **University research in area of software reuse processes**

Cost Allocation of Negotiated Baseline
(Development Labor)

Development Labor = 27 % of Total Program = 27% of $766M = $207M



Cost Allocation Backup Information
(Development Allocation)



System Engineering

- **Requirements / external interface analysis**
- **System architecture/design/operations concept**
- **System modelling**
- **Life cycle cost analysis**
- **DAAC engineering liaisons**

Segment Development (SDPS, CSMS, FOS)

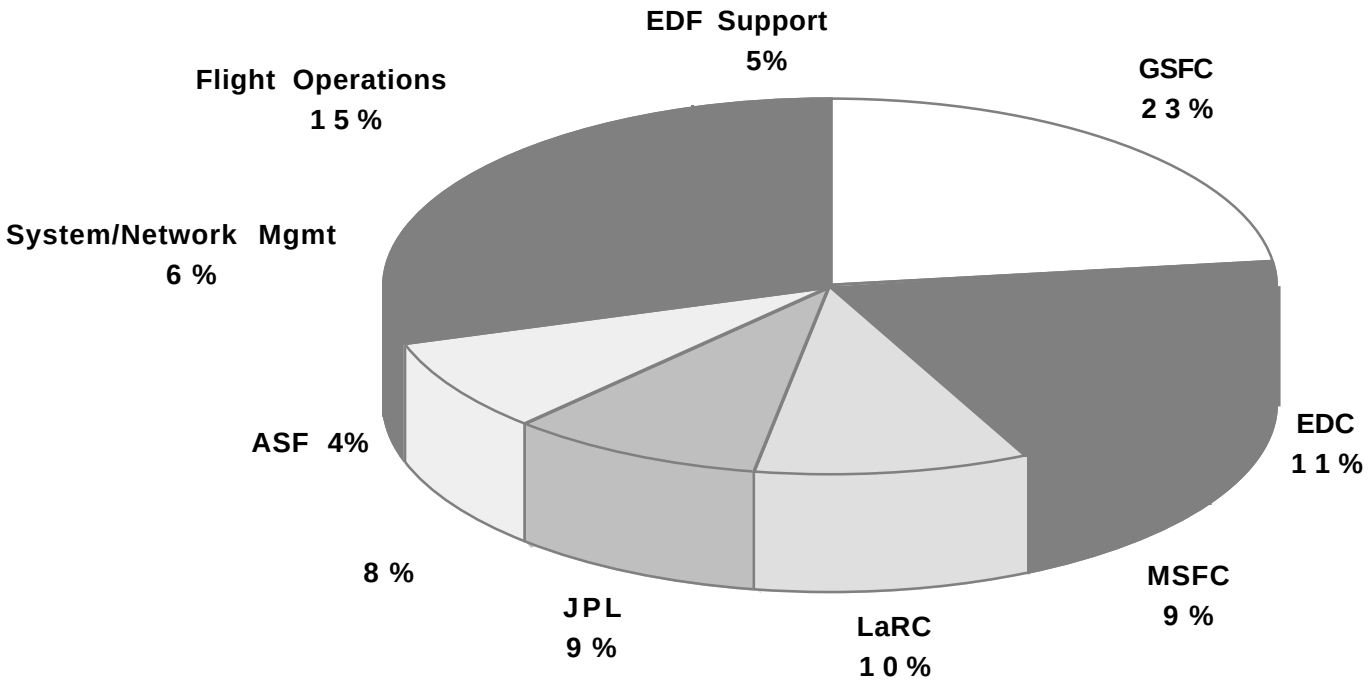
- **Segment engineering**
- **Design, code and checkout**
- **Segment integration & test**

Science Office

- **Science user interface for requirements understanding**
- **Algorithm Integration & Test Support**
- **DAAC science liaisons**

Cost Allocation of Negotiated Baseline (M&O)

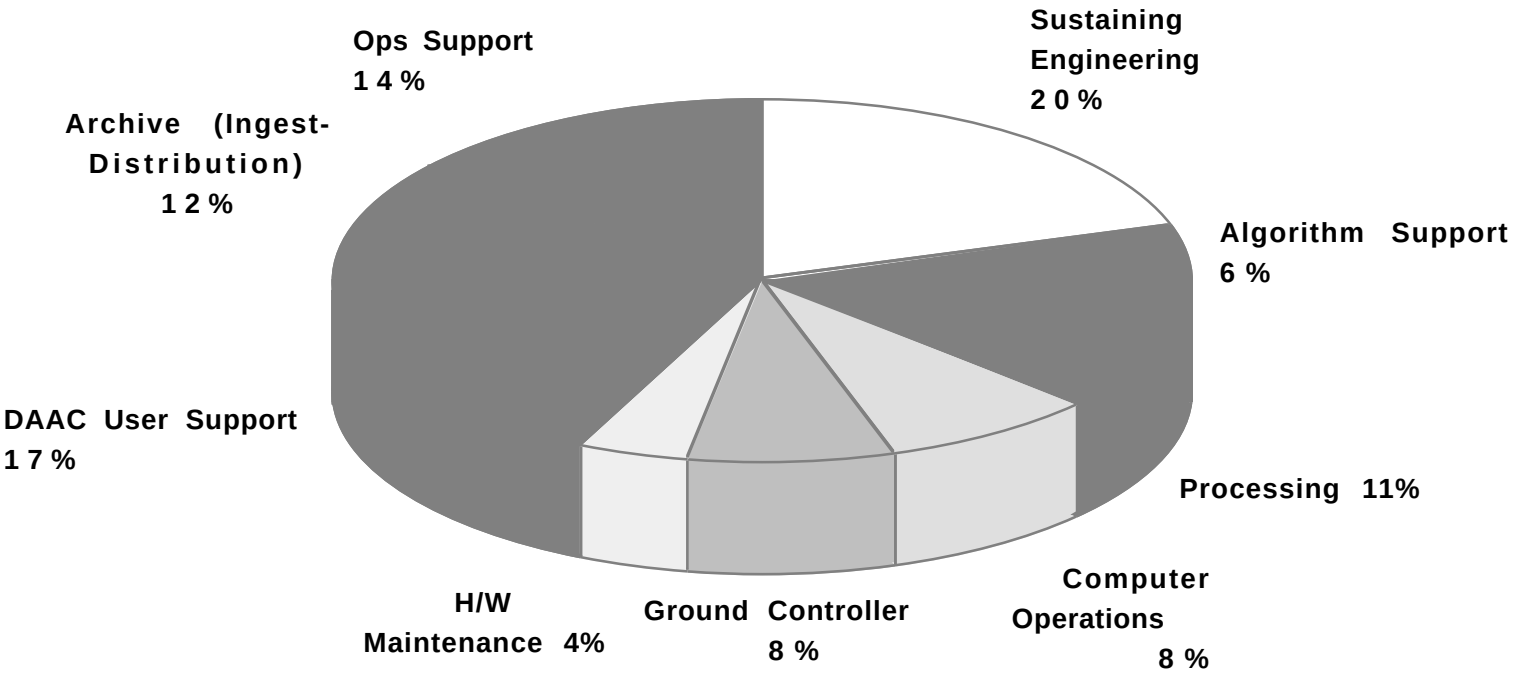
M&O = 34% of Total Program = 34% of $766M = $260M



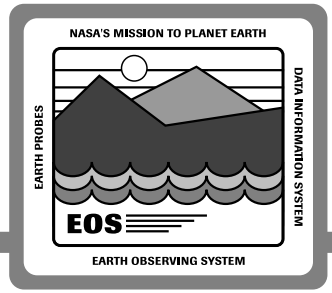
Note: All DAAC Support = 74% M&O Labor

Cost Allocation of Negotiated Baseline
(DAAC Operations Support)

DAAC Operations Support = 74% of M&O = 74% of $260M = $192M



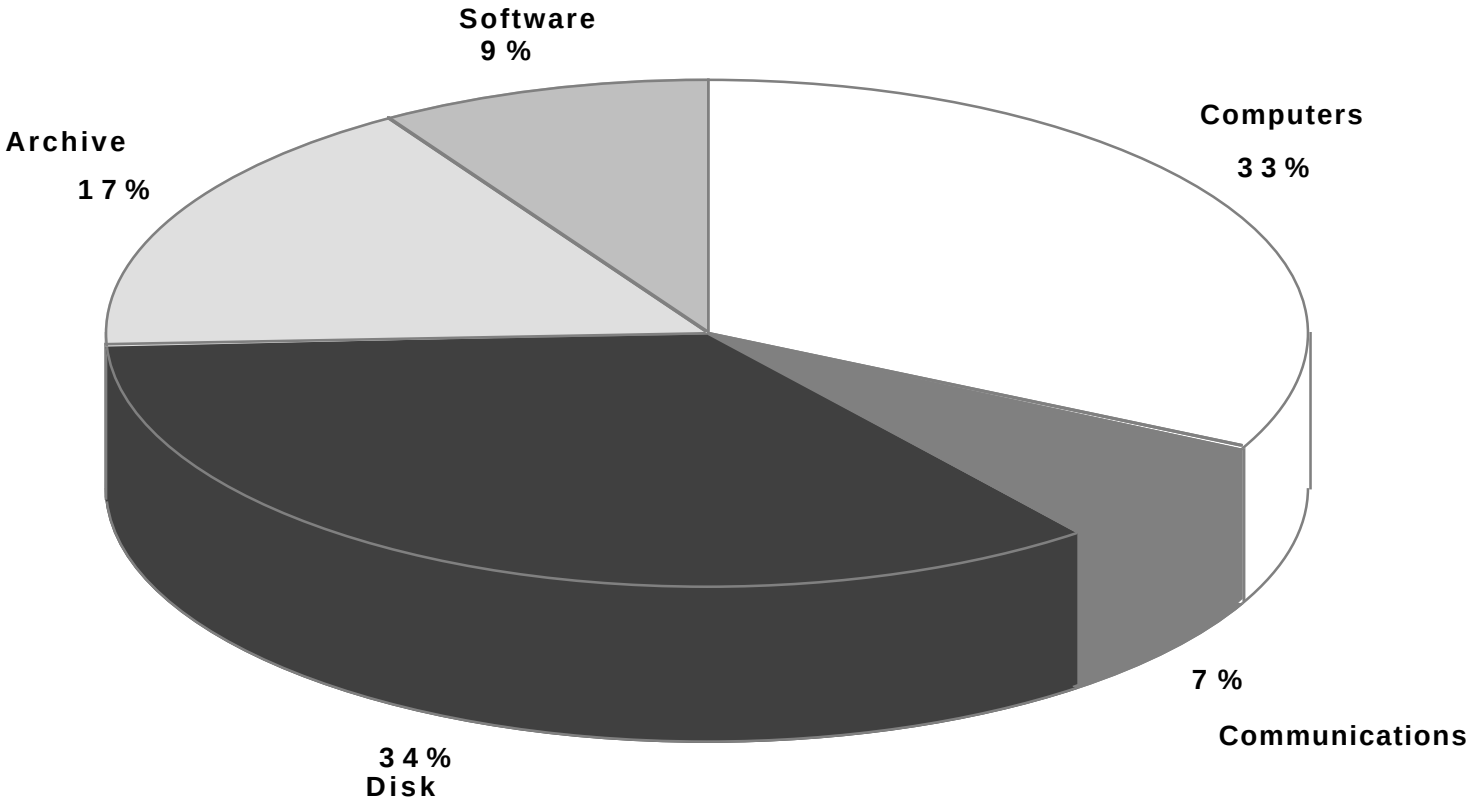
DAAC Staffing Examples



Function	EDC	ASF
Sustaining Engineering (S/W Maint, CM, Testing, Upgrades)	11.0	5.4
Algorithm Support (Development, Test & Integration)	2.8	N/A
Processing (Ops Supervision, Scheduling, QA)	8.2	N/A
Computer Operations	4.7	4.7
Ground Controller	4.2	4.2
H/W Maintenance	2.0	0.4
DAAC User Support	12.2	4.2
Archive (Ingest, Distribution)	11.4	1.0
Ops Support (Admin, ILS, Ops Readiness, Data Base Admin, Performance Analysis, Resource Control)	5.3	3.8
Peak Staffing Totals	61.8	23.7

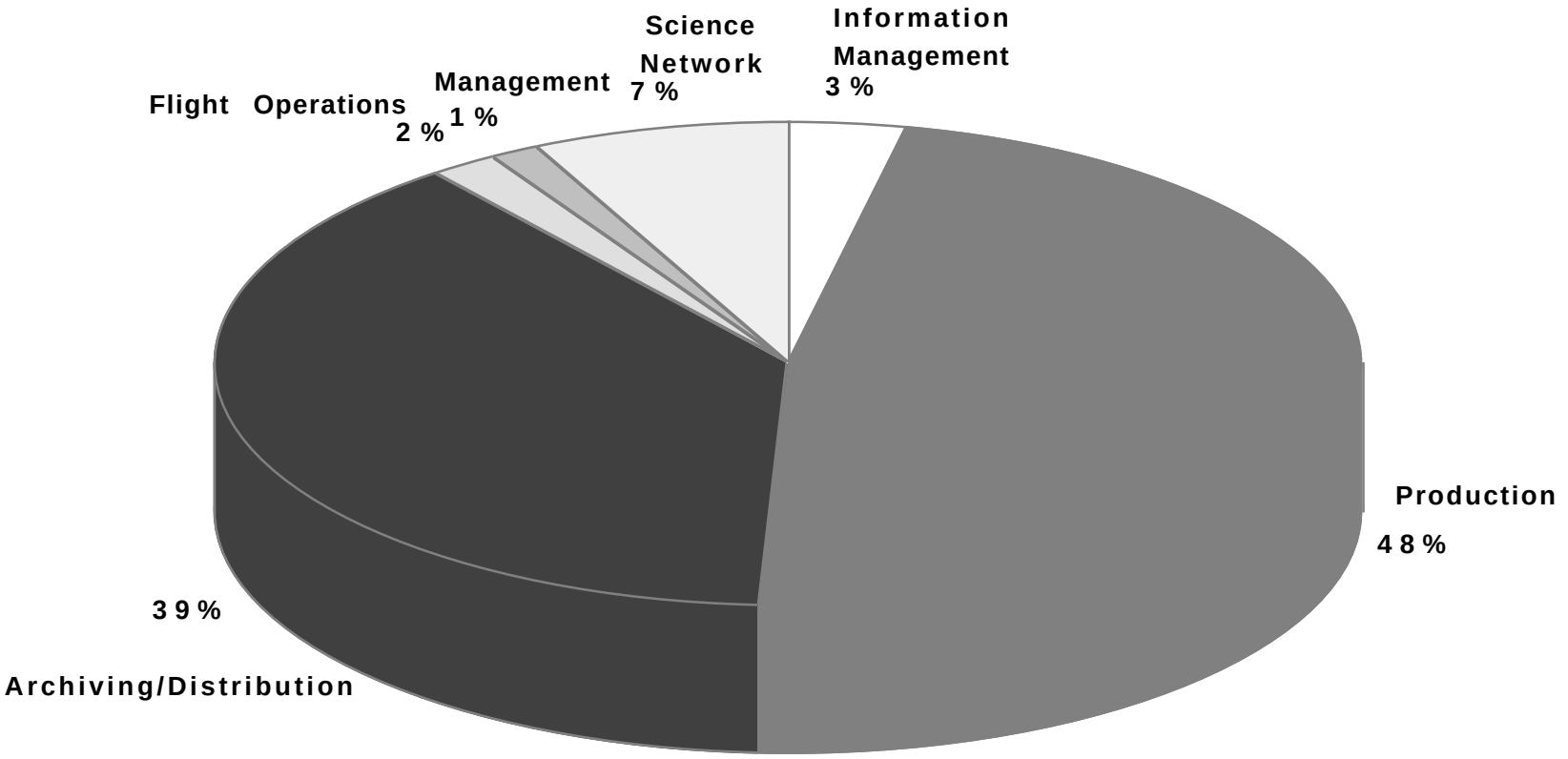
Cost Allocation of Negotiated Baseline (COTS by Type)

COTS = 14% of Total Program = 14% of $766M = $107M

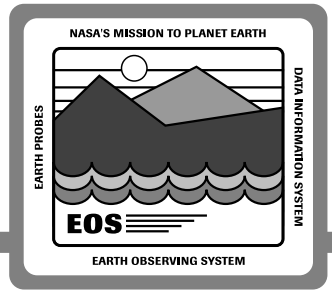


Cost Allocation of Negotiated Baseline (COTS by Component)

COTS = 14% of Total Program = 14% of $766M = $107M



Cost/Performance Roadmap



SRR Issue Description

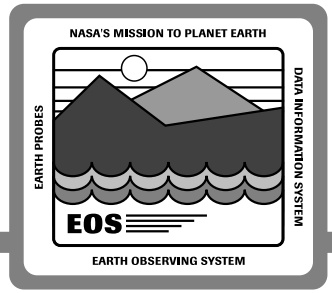
Cost/Performance Analysis Approach

Baseline Cost Allocation (Preface to Tradeoffs)

Cost Tradeoff Analysis

- **Operations Staffing Options**
- **Evaluation of increased processing/storage requirements of "tall-pole" products**
- **Processing vs Storage**

Reduced DAAC Operations Options



Baseline:

- **Three 8 hr Shifts, 7 days/week (full functionality at all times)**

Alternatives:

- **Two Shifts (prime time = 16 hours/day, 7 days/week)**
- **Extended Day Shift (prime time = 12 hours/day, 7 days/week)**
- **Day Shift (prime time = 8 hours/day, 5 days/week)**

Options during “non prime time”:

- **Reduced Staffing (Limited functionality)**
- **No Staffing (Lights out operations)**

Potential Savings as % of DAAC Operations Support
(Through Oct 2002)

Prime Time Staffing Options	Non Prime Time Options: Reduced Staffing	Non Prime Time Options: No Staffing
Two Shifts (16 hrs/day, 7 days/wk)	4.0% ($7.7 M)	8.7% ($16.7 M)
Extended Day Shift (12 hrs/day, 7 days/wk)	6.0% ($11.5 M)	13.0% ($25.0 M)
Normal Day Shift (8 hrs/day, 5 days/wk)	8.2% ($15.7 M)	17.9% ($34.4 M)

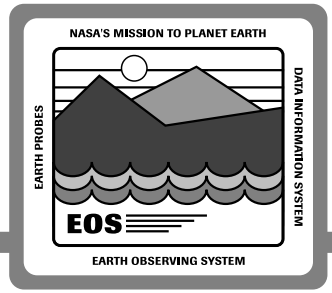
Note: Assumes processing and electronic access/distribution of data continue during "non prime time" (Additional H/W or S/W not included)

24 Hr Shift Positions at DAACs

DAAC / Position	GSFC**	EDC**	JPL*	LaRC**	NSIDC*	MSFC*	ASF
Ground Controller (LSM)	Y	Y	Y	Y	Y	Y	Y
QA / Production Monitor	Y	Y	Y	Y	Y	Y	N
Archive Manager	Y	Y	Y	Y	Y	Y	N
Computer Operator	Y	Y	Y	Y	Y	Y	Y
Data Specialist	Y	Y	Y	Y	Y	Y	Y
Data Distribution Tech	Y	Y	Y	N	N	N	N
H/W Maintenance	Y	N	N	N	N	N	N

Notes:
Outlined indicates positions staffed during periods of reduced staffing.
*** Daily processing loads currently projected for AM-1 are less than baseline.**
**** Daily processing loads currently projected for AM-1 are greater than baseline.**

Human Interface vs Automation

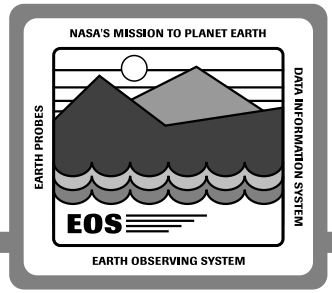


Expert systems were already projected in determining the negotiated M&O staff

Additional areas for potential improvement:

- **User Support Services**
- **Algorithm Integration and Test, Production Monitoring, Product QA**
- **Ingest, Archive Management, Electronic Distribution vs Hardcopy**
- **Network User Support**
- **H/W Maintenance**
- **Flight Operations**

Cost/Performance Roadmap



SRR Issue Description

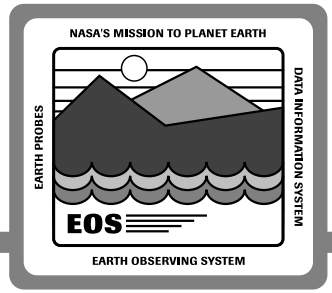
Cost/Performance Analysis Approach

Baseline Cost Allocation (Preface to Tradeoffs)

Cost Tradeoff Analysis

- **Operations Staffing Options**
- **Evaluation of increased processing/storage requirements of "tall-pole" products**
- **Processing vs Storage**

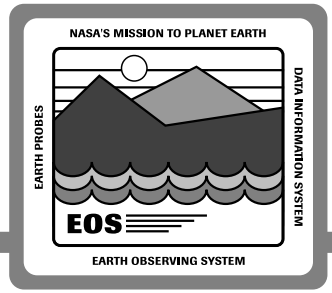
Analysis of Requirements for "Tall Pole" Products



Analyzing latest product survey that reflects increase in processing and storage/distribution requirements

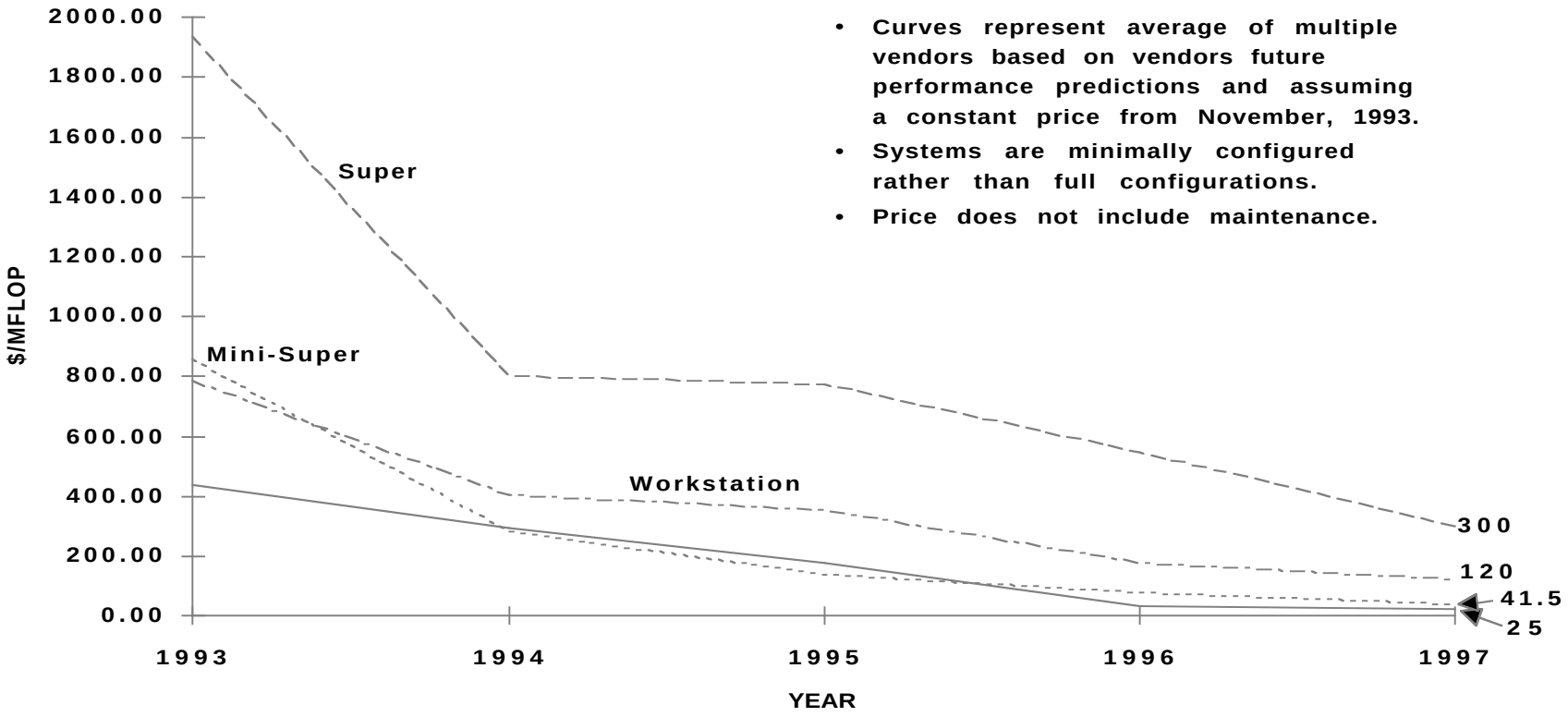
- **Currently evaluating 6 "tall pole" products from Processing perspective (2 MODIS, 4 MISR)**
  - **Determining impacts for various processing architectures**
  - **Also evaluating impacts of storage requirement increases**
- **Working with science teams**
  - **Evaluating and understanding estimation processes**
  - **Evaluating applicability of parallel processing architectures for algorithms**
  - **Working on plans for joint evaluation of algorithms prototypes on different processing architectures (Networked Workstation prototype using Parallel Virtual Machine (PVM) product planned for STL)**
- **Plan future analysis of complete product survey in 1st quarter 94**

Tall Pole Products



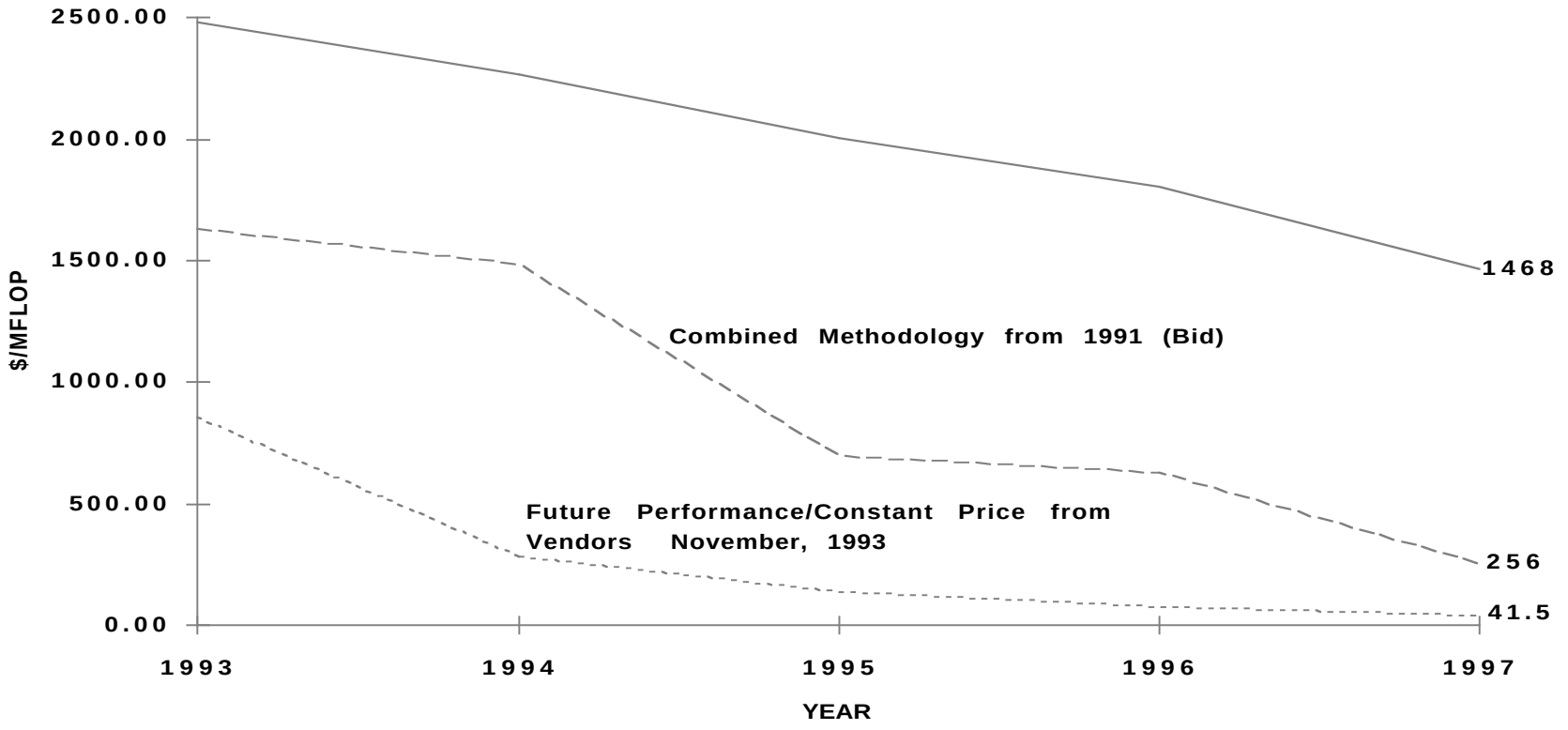
Product	Level-1B2 Product		Aerosol Product	Surface Product		Water-leaving Radiance	
Product ID	MIS03	MIS04	MIS05	MIS06	MOD02	MOD18	TOTALS
MFLOPS	3,312.00	784.00	2,896.00	3,294.00	3,000.00	1,200.00	14,486.00
GB/Day	81.10	8.60	3.40	7.10	500.00	11.69	611.89
GB/Day - Delta from Baseline	65.29	8.00	2.80	6.50	300.00	10.87	393.45

Price/Performance Curves

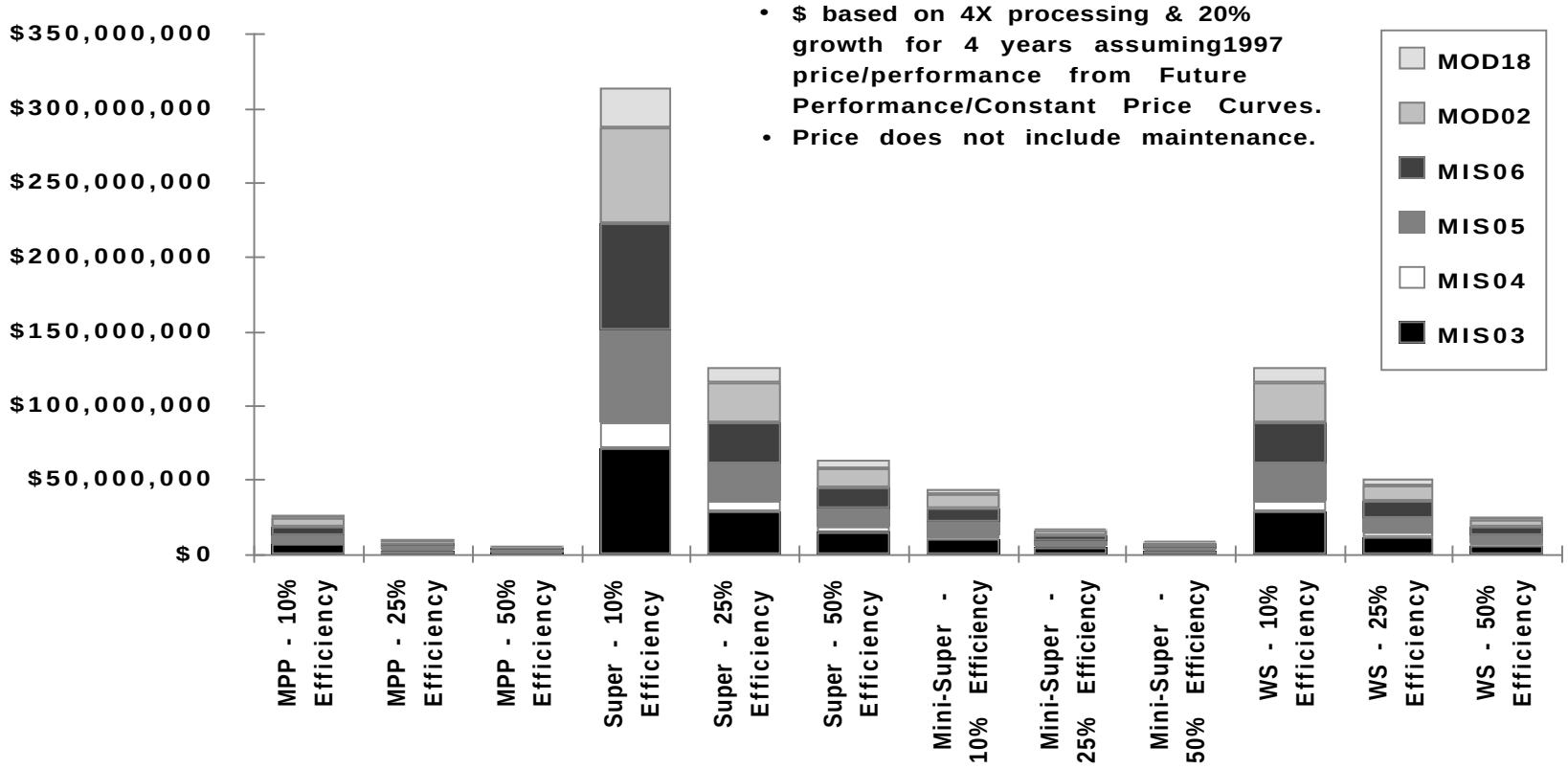


- Curves represent average of multiple vendors based on vendors future performance predictions and assuming a constant price from November, 1993.
- Systems are minimally configured rather than full configurations.
- Price does not include maintenance.

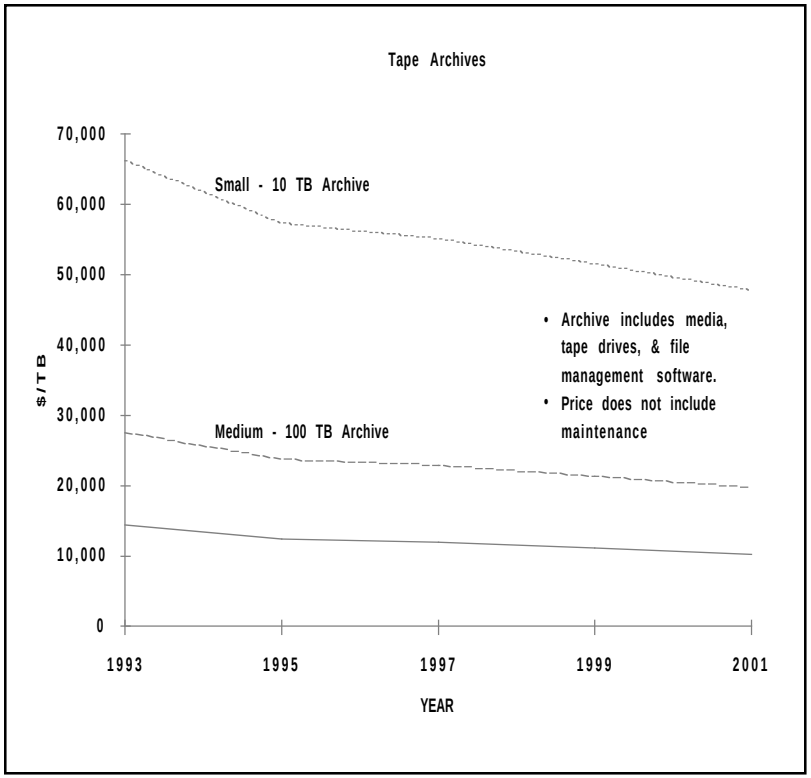
Mini-Super Price/Performance

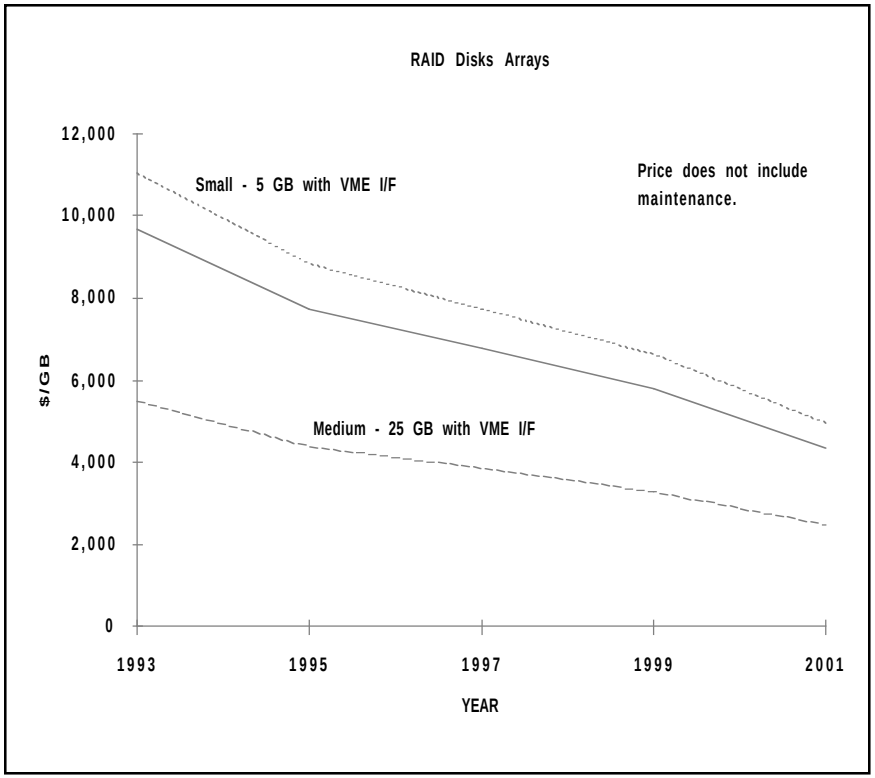


Tall Pole Processing Impact

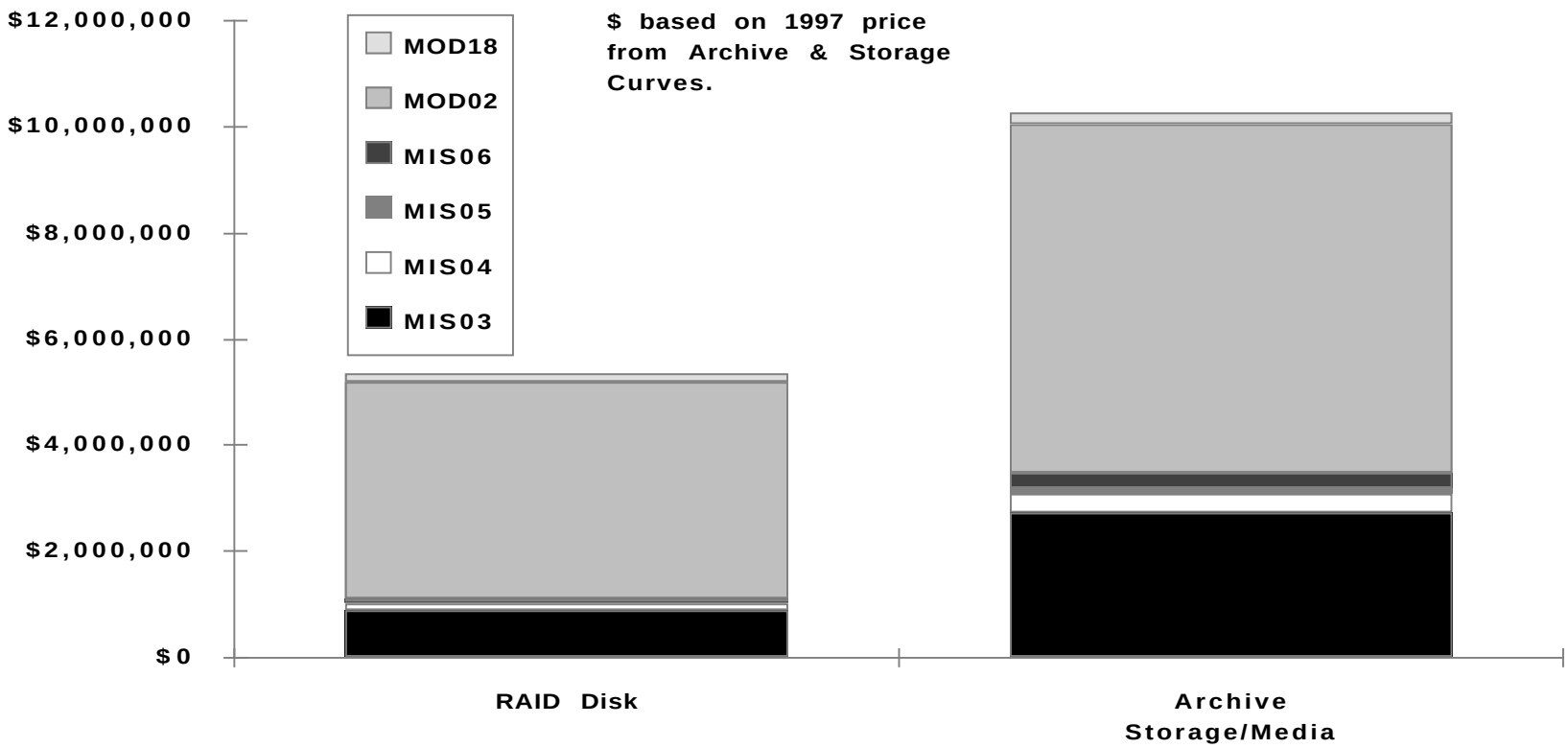


Archive & Storage Curves

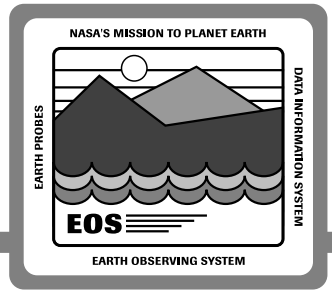




Tall Pole Storage & Archive Impact



Conclusions of Tall Pole Analysis



With expected significant decreases in price/performance for processing technology, purchase commitments should be delayed as long as possible

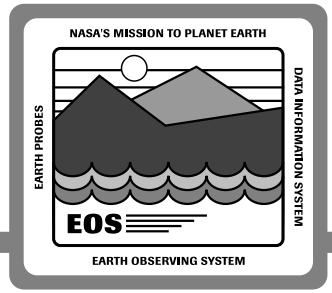
In near-term, expect price/performance of processing to decrease much faster than storage technology

- **Implies periodic evaluation of process vs storage decisions**
- **Previous programs indicate need for processing capacity almost always increases over the life of the program**

If processing capacity of MPP architectures can be effectively utilized it may be the proper solution

- **Expect additional development effort**
- **Possible use of network or cluster workstation architecture may be more effective**

Cost/Performance Roadmap



SRR Issue Description

Cost/Performance Analysis Approach

Baseline Cost Allocation (Preface to Tradeoffs)

Cost Tradeoff Analysis

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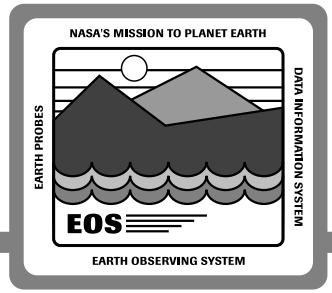
Options for Standard Product Generation



Policy : Standard products are to be produced and made available at the DAACs according to timelines specified in Level 1 requirements

Three implementations options are:

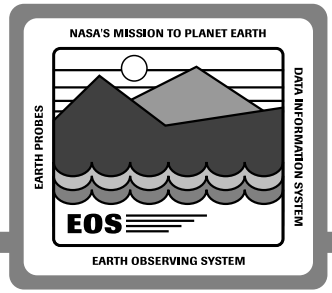
1. **Always generate product and archive the results**
   - **Standing orders are distributed before archiving**

2. **Generate the product only when a user requests it**
   - **Optionally short-term cache product to handle multiple Interested parties**

3. **Transfer to requester the algorithm and all input necessary for production**

Process vs Storage trade focuses on first two implementations

Issues Affecting Process vs Storage



Ability to Search Data

- **Rich metadata not available until first processing**
- **Content-based searches computationally intensive**

Access Pattern

- **Some granules may be less frequently accessed**
- **Process On Demand may Increase "Pull" on archive**

"Best" algorithm versus consistent data set

Heritage at end-of-project

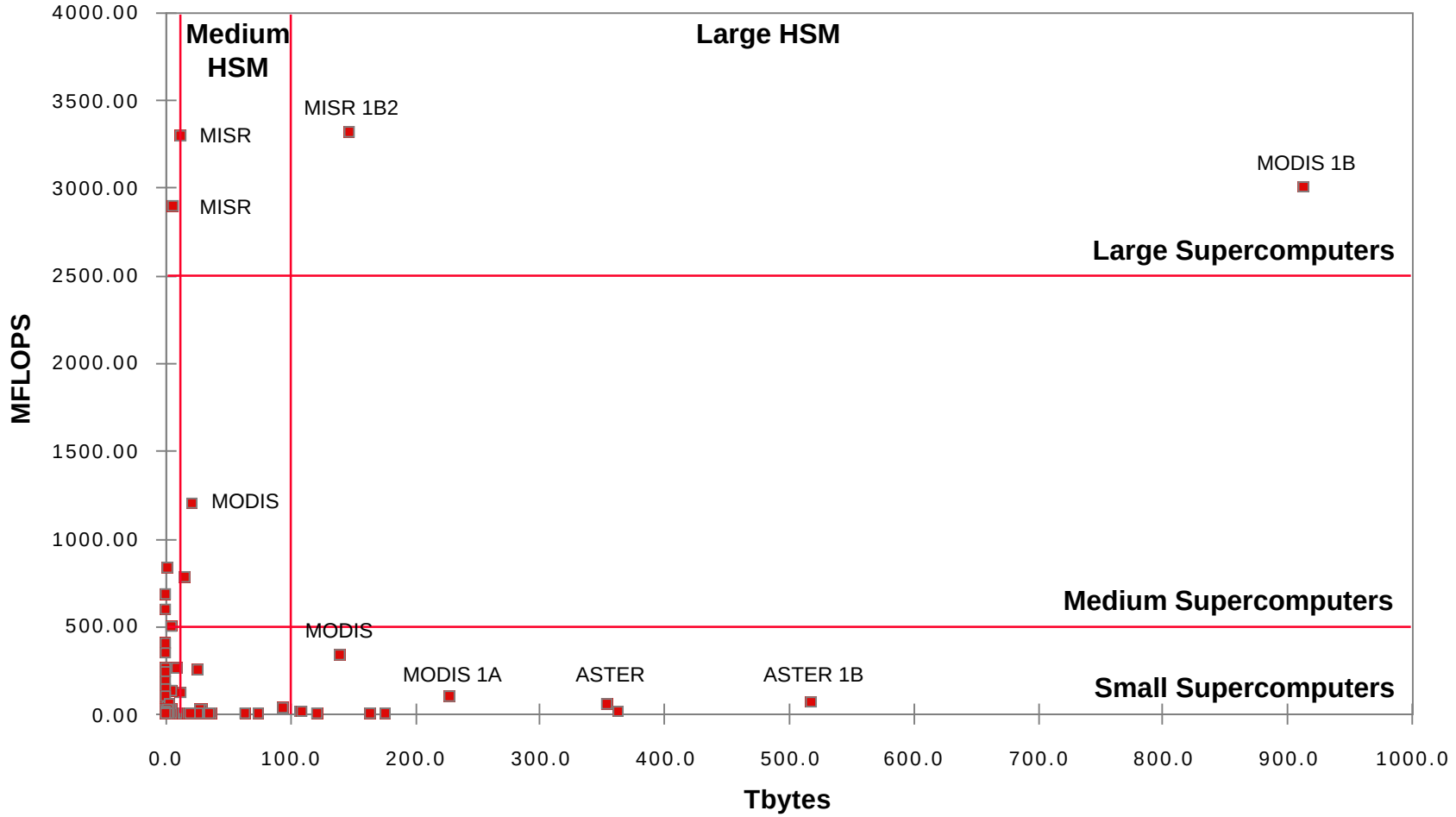
Technology advances over a 10-20 year program

- **Even if no media refresh needed, availability of read equipment needs to be assured**

Cost-to-Produce versus Cost-to-Archive ($, Time)

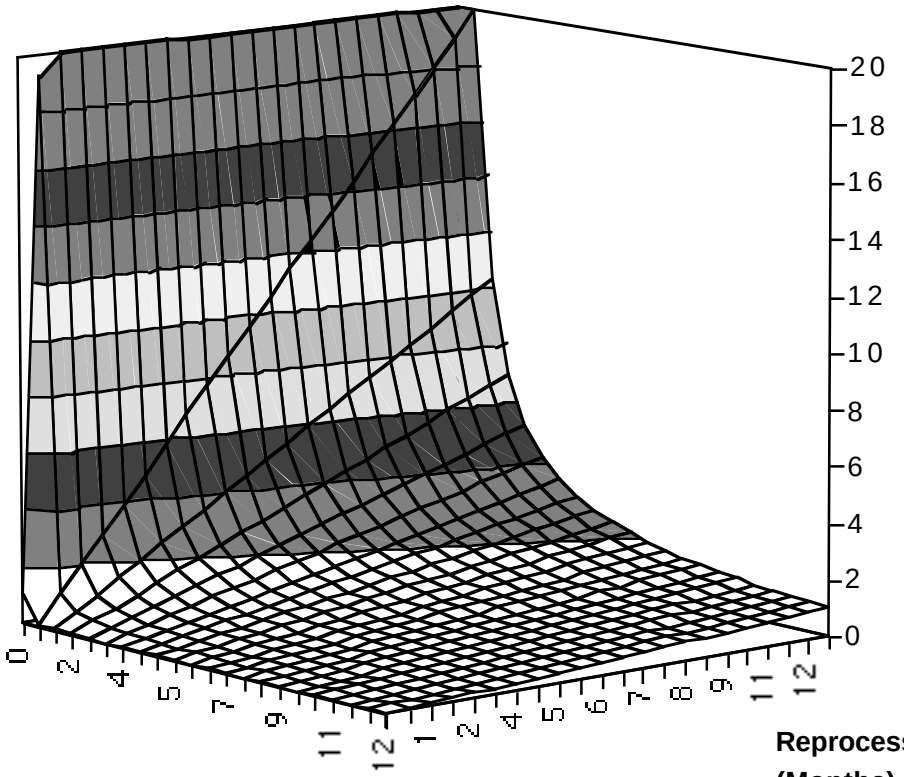
Product Requirements

Processing Load vs. 5-year Storage Volume



Data Source: SPSO / Dr. King Survey

Cost Leverage (Single Product)

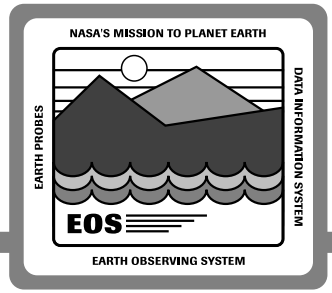


Normalized Cost (Process/Archive)

Access Interval (Months)

Reprocessing Interval (Months)

Current Views and Recommendations for Process vs Storage



Process vs storage is an adaptive decision

- **Per data set basis**
- **Per granule should be studied**

Decision needs to be regularly revisited

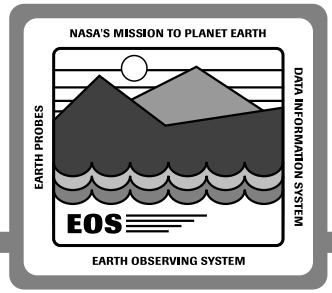
Initial assumption needed by CDR of appropriate release

- **TRMM: Release A**
- **AM1: Release B**

Architecture will be designed to support adaptive decisions

- **Implies mix-n-match, modular process, archive, and cache Servers**
- **Processing service must allow specification of option at data set level**
- **Proper statistics must be gathered to aid in making intelligent decision**

Future Plans



Complete analysis of new product survey in 1st quarter 94

Develop system model used to perform detailed sensitivity analysis

- **Required processing, caching, archive and communication bandwidth**
- **Determine expected system response for various service requests**
- **Determine impacts of user/data modeling input**
- **Perform more complete analysis of process vs storage trade**

Plan to have initial system model developed during first 6 months of 94 to support system architecture/design analysis